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ABSTRACT

Dynamic discussions have begun to emerge concerning style of presentation on world wide web sites. Some hypertext markup language (HTML) designers seek an intimate and chatty ambience, while others want to project a more professional image. Evaluators see many sites as overdecorated and indecipherable. This paper offers suggestions on selecting projects and design types appropriate to HTML and also on maximizing clarity and navigability while creating hyperlinks and displaying text. The incorporation of images, and even short movies, is becoming increasingly popular, but often such files are too large to be manageable or practical. The designer can reduce the size of the image or movie window, reduce the bit depth of the colors, or reduce the number of frames per second of moving images. Studies were conducted to investigate how altering images in these ways influence loading time, file size, and perceived quality. Six figures, including reproductions of computer screens, and two tables illustrate the discussion. An appendix provides uniform resource locators (URLs) for 46 clip art and icon collections on the world wide web. (BEW)

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Designing Multimedia for the Hypertext Markup Language

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Designing Multimedia for HTML

The World Wide Web invites anyone to publish sophisticated thought or unimaginable palaver without discrimination. Despite the opaque nature of HTML (HyperText Markup Language), and the limitations of most computers and their lines to handle large amounts of data efficiently, vast amounts of information are being added to the Web daily. Multimedia resources, and especially learning resources, make up a large portion of what is available on the web; some are well designed while others are not.

Designing an HTML page is both a technical and artistic challenge. Some of the technical issues are dealt with in a companion paper (Misanchuk and Schwier, 1996). We're coming to the opinion that design and good taste, while perhaps overblown and over-sold as important to learning, aren't entirely intuitive. Elizabeth Boling commented that when some people design their first web pages, "they seem to gravitate to (embrace?) the most vulgar forms--blinking text, egregious menu bars, decorative graphics, indecipherable icons" (personal communication, December 2, 1995). Our experience has been similar. Without any coaching beyond the technical "press this key, then that one" variety, we turned a group of students loose on designing a web page. The task was to introduce themselves to the educational technology community in Canada with a brief textual description and a photo. Well, you can probably imagine what happened--blinking text, headings and subheadings by Freddie Krueger, and writing styles that ranged from point form lists of accomplishments to cute and disarming stories about pets and children. We found the differences in writing styles were very interesting. There were very different assumptions about what material on the web "should" look like. Some (we suspect the ones who have a great deal of casual web experience) seemed to think that the material should be personal, intimate, casual and chatty. Others wanted to project a professional image, and thought the casual material was trivial. What has emerged from the experience is a very dynamic discussion of "style of presentation" on the web.

A host of design considerations obtain once a designer has elected to publish a multimedia document using HTML. This paper considers several design considerations in turn, the first of which is how to select appropriate projects for HTML production.

Selecting HTML Projects

Currently, the majority of connections to the World Wide Web are too slow to adequately display the full range of multimedia options. Most modems operate at 14,400 bps, with newer technology operating at 28,800 bps. This is woefully inadequate for loading large graphics, movies, and sound files to the user. For example, the promotional copy for the Mac&Fax Sportster fax/data modem boasts that the modem "Speeds graphics files to service bureaus—a 2MB graphic file that takes 2.5 hours at 2400 bps takes only 23 minutes with the Sportster 14,400 Mac&Fax" (U.S. Robotics, 1995). Considering that most learners will not wait 23 seconds, let alone 23 minutes, for a graphic to appear on the screen, the advertising copy argues forcefully against using a great deal of multimedia when designing for the web. Even ethernet connections can be slow at times. So the first guideline for selecting HTML multimedia projects is:

think, and then think small.

Designers also need to consider that the end-user has a great deal of control over the features of a document—margins, background colours, text size and font. This requires designers to design robust documents which can survive choices and indignities imposed by users—the instructional design equivalent of child-proofing your home. This leads to the second guideline for selecting HTML projects:

select designs the learner can influence.

Interaction, especially interaction of the "point and click" variety, is possible with HTML. But answer judging isn't necessarily easy to accomplish. Linking, of course, is its strongest feature, and a healthy amount of interaction is possible by allowing learners to trace unique paths through information. Other types of interaction are better left to authoring systems designed for that type of production. HTML's strength is organizing information systems, so a third selection guideline is:

give preference to information-based projects.

File Management

HTML usually requires the designer to link several documents, and this can influence the execution and appearance of a project. Home pages should be small, without elaborate or unnecessary graphics, This allows users to load the files quickly. Few things are as annoying (and sometimes expensive) for users than to wait a long time to load a home page, only to discover that the information at the site is not what was wanted in the first place.

In HTML documents, it is conventional to identify head, title and body elements (<head>, </head>, <title>, </title>, <body>, </body>). Why? These tags facilitate searching and indexing. As searching engines for the web continue to evolve, these labelling conventions will help confine searches to the fields identified for the search, and make searching much more efficient. Titles should be as short as possible to further facilitate searching.

Add contact information to the home page. As a courtesy to users of any web site, it is conventional to include a method of contacting the author, perhaps with an e-mail address or phone number. It is simple enough to automate a mail function.

It is conventional to embed links naturally within prose unless there are many of them, in which case "bulleted" lists are preferable. This convention is probably an aesthetic, rather than an effectiveness concern, but we know of no specific research on this topic. Still, it is probably good advice to keep links as unobtrusive as possible, yet apparent to the user. Embedded links are less likely to break up the flow of a document for the reader.

A good research problem is to examine the effectiveness of long/short links and multiple links. To our knowledge, nobody has yet investigated user preference or the effectiveness of different linking strategies.

It is generally a good idea to build links to other documents, rather than to locations within a single, large document. For example, a list of links can each be tied to an external file, and that file can provide a link back to the "jumping-off" position in the original document. This provides easy navigation back and forth. By contrast, consider a large document in which links are tied to different positions in the body of the document. Once you jump from one place to another in the document, how do you build the link to the next place in the document? Awkwardly. It is difficult to include "return to point of departure" links in the document when each destination may have originated from several different location. Most users will survive by using the "back" button in browsers such as Netscape, but this is an awkward

solution at best, and outside the control of the instructional designer. Another advantage of linking several smaller documents is improved execution time. A large document will require a long time to load, and this is an inefficient use of connection time if the user is going to look at only a small subset of the information on the page.

Text Display and Layout

The layout of information includes the position of text and images, the use of tables to establish columns of information, the production of lists and preformatted text, and the incorporation of external images, sounds and animation. A well-designed project layout considers both the design of a particular page and the layout of several logically related documents.

Textual display, while significantly under the control of the user, can still be manipulated by the designer. At the very least, recommendations can be given to the user on how to set up the display if the textual design is critical. It is important to remember that despite the unique and sometimes frustrating nature of writing in HTML, age-old principles of good document design should be observed. Probably most importantly, documents should have a consistent presentation style.

HTML layout commands are divided into two types: logical and physical elements. Logical elements are tags which define which design elements are placed on the screen, but leave the decisions about how they look up to the user. For example, a logical element tag is <EM> </EM> which stands for emphasis and <STRONG> </STRONG> stands for strong emphasis. Depending on the choices made by the learner, the browser may display emphasized text as italics, or red, or underlined.

Physical elements, on the other hand, try to wrest control of the design from the user, and impose very specific limits on the design. For example <I> </I> stands for italics and <B> </B> stands for bold-facing, and these will be imposed on text, regardless of the wishes of the user. These are also subject to the limitations of any particular browser to display the physical elements imposed.

You will find that most resources argue in favour of using logical elements, and giving the design control over to the user. As desirable as this might be in most cases, it challenges designers to anticipate the mess learners can make of materials.

Another thing to remember when laying out text is that layout tags don't necessarily operate the way one might predict. For example, the paragraph tag <p> marks a container for text--not a space insertion as in word processing. HTML recognizes only the largest spacing value of a logical structure element (e.g., <p>, <br>) will be used. This means that an HTML document displays command structure <p> <p> <p> <p> the same as <p> in most browsers.

The <PRE> element is used in HTML to force text into columns or other alignments. Space text with the space bar (not with tabs, etc.). This is the only way to display tabular data with HTML 2.0.

A simple strategy for developing elaborate designs is to copy source code for an appealing design or strategy, and manipulate it to fit your material. This can save time, but can also constrain the designer to the limits imposed by the original, and more skilled, programmer.

Image Use and Display

Images can be stored in only a few formats if they are to be used within documents. Images can be in one of three formats:

.gif GIF format image file
.xbm X-Bitmap (black and white)
.xpm X-Pixelmap (colour)

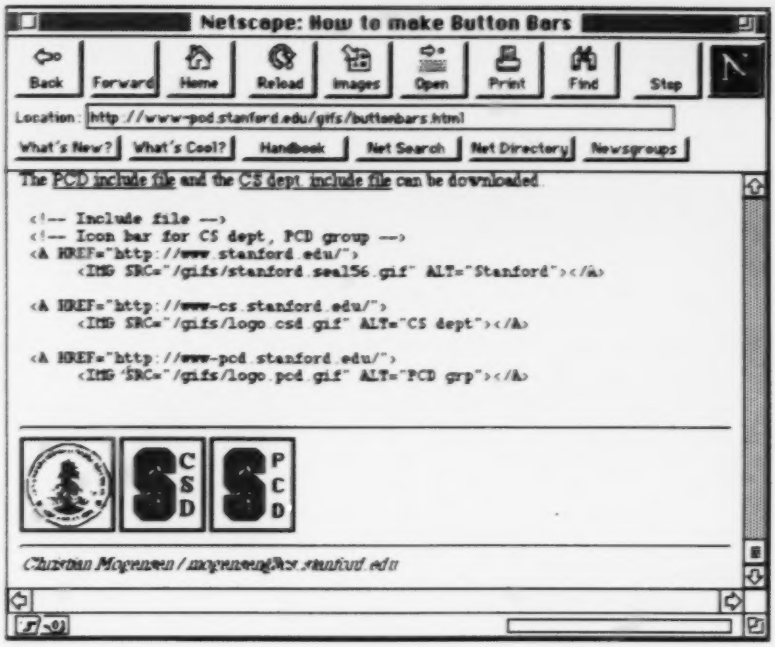
Other formats such as JPEG are possible to use, but require helper applications to be displayed (see Misanchuk and Schwier, 1996 for an explanation of helper applications).

Icon archive sites are plentiful on the internet. We conducted a simple search on January 7, 1996 using keywords "clip art" and "icon". The URLs in Appendix 1 were the first 46 "hits" in a list of 100. We make no claims as to their usefulness or their content, but list them as a jumping-off point for you if you are looking for clip art and image collections for your own projects. The content ranges from business icons to wedding art. Publications also include sites for locating icons and artwork (e.g., Graham, 1995), but we suggest you also conduct your own searches on the WWW, because sites and URLs are very volatile, and often change before print documents can reach publication.

A particularly attractive, and perhaps effective, navigation strategy is to employ "clickable" pictures. These can be accomplished in on-line HTML applications, but not necessarily easily. A companion program is required to map transparent buttons onto the pictures. The actual procedure for producing imagemaps can be daunting, but Frost (1996) provides a very useful, step-by-step description of how to script an imagemap for beginners. Active images <IMAGEMAPS> also require an HTML program to access a gateway program active on the system (Frost, 1996; Graham, 1995). It appears that this mitigates against using CD-ROM as a medium for using imagemaps. A related, if not quite as elegant solution is to produce a "button bar" or series of small thumbnail images in a line, each of which acts as a separate navigation button (see Figure 1). This is somewhat easier to accomplish and it doesn't require the active gateway program to operate. For specific advice and examples of how to script a button bar, a good resource is provided by the Stanford Computer Science Department at:

http://www-pcd.stanford.edu/gifs/buttonbars.html

Figure 1. Example of button bar from Stanford Computer Science Department.



When including images, it is good manners to always use <ALT="text description of the graphic"> to orient readers who are using browsers that can't display images.

Images are treated as large letters--surrounding text can be aligned next to the image but it is important to include a special alignment (Img align=left) and line break command to clear the image and move to the next available space (br=clear left). Otherwise text and images will not align properly next to an image. An example drawn from Highland Graphics (http://www.itsnet.com/home/highland/raytrace.html) illustrates the principle (Figure 2).

Figure 2. HTML script and associated screen display which aligns text next to graphics.

```
<B>Click on the small image to view a large version.</B><P>

<A href="fracbals.gif"><Img align=left Img width=128 height=96 src="s-
fracba.gif">Fractal Balls</a> - The

fractals were created with Fractint then mapped onto the spheres in 3d Studio.


<BR clear=left>

<A href="mobius01.gif">

<Img align=left Img width=128 height=96 src="s-mous01.gif">Mobius 1</a>

- The shape was created in the 3d Studio shaper program,

saved as a 3ds file, converted to Povray then raytraced in Povray.
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Netscape: Highland Graphics - Raytracing!
Back
Forward
Home
Reload
Images
Open
Print
What's New?
What's Cool?
Handbook
Net Search
Net Dire
Highland Graphics - Raytracing!
News images added as of July 21, 1995.
Besides clipart we also play around with computer generated images. Using both Raytracing and Rendering software you can create rather realistic looking images. Feel free to download these and use them as background images. Commercial use of these images is not allowed without written consent from Highland Graphics.
For more information about raytracing, rendering or Povray check out one of these links:
The Ray Tracing Home Page in the UK.
Or check out the POVRAY OFFICIAL FTP SITE.
Click on the small image to view a large version.
Fractal Balls - The fractals were created with Fractint then mapped onto the spheres in 3d Studio.
Mobius 1 - The shape was created in the 3d Studio shaper program, saved as a 3ds file, converted to Povray then raytraced in Povray.
Document: Done.

A persistent problem when using graphics is the size of picture files. There are two ways to reduce the size of picture files:

1. reduce the size of the image; or

2. reduce the number of colours (bit depth) when creating the files.

GIF files are restricted to 8 bit (256) colours. JPEG images can be used for greater bit depths, and16 bit (thousands) and 32 bit (millions) colours are typical. Adjustments to either of these variables will affect the quality of the image when it is displayed on screen. Whether or not the quality difference is perceived, and whether the increased file size and loading time is worth the concomitant increase in perceived image quality is often a difficult judgement to make. We were unable to find any research which directly addressed these questions, so we designed an experiment to determine the actual costs and perceived quality differences when the size and bit depth of an image are manipulated.

Research Questions:

How will larger and smaller pictures compare in file size, loading time and perceived image quality?

How will altering the bit depth of images influence their file size and perceived quality?

Subjects:

Fifteen graduate students and senior undergraduate students studying educational technology, and seventeen adult employees at the University of Saskatchewan volunteered to participate in the study.

Treatment:

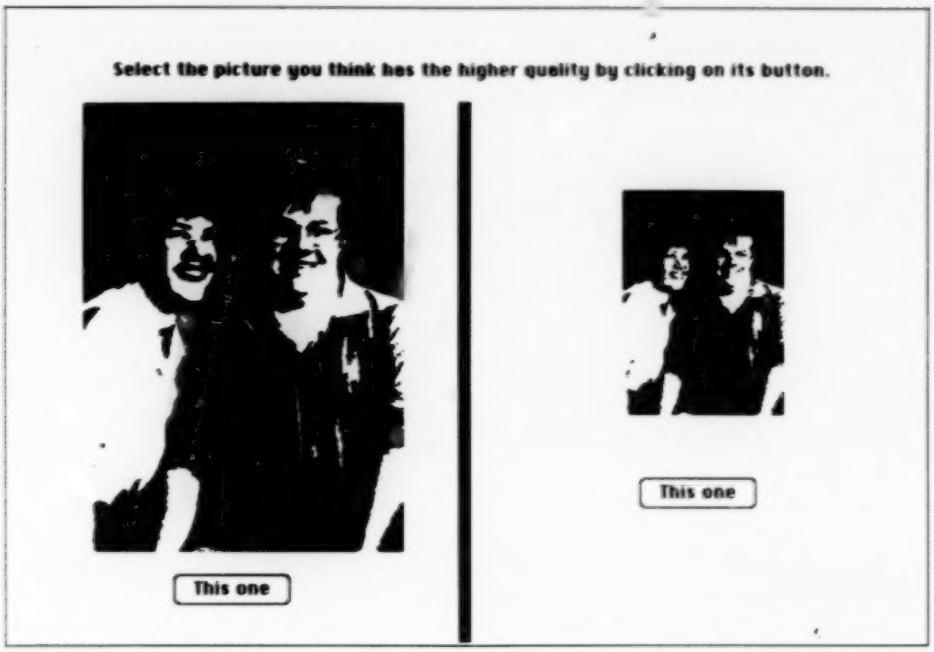
To measure perceived image quality, a full-colour 5" x7" portrait was scanned on an Apple II Colour Scanner at the highest quality settings. The resulting file was imported into Adobe Photoshop to create six versions of the photograph, including two image sizes (640 x 480 pixels) and three colour quality settings (32 bit, 16 bit, and 8 bit). Each was saved first as a PICT file, and subsequently as a JPEG and GIF file without any type of compression algorithm. Each image was imported into a program created with Authorware Professional v. 2.2, and a series of "pages" created to provide a paired comparison of every possible combination of image variables. The order of comparison was constructed according to recommendations by Ross (1934) for conducting paired comparisons to eliminate effects of picture location and presentation order. A Thurstone Scale was constructed for comparing resultant data (Torgerson, 1958).

GIF files were created by converting the PICT files using Photoshop v.2.5.1. PICT file colours were indexed at 8 bit colour (256 colours), and saved in the Compuserve GIF format. HTML image file formats require 8 bit colour indexing. This means that the quality comparisons of picture files with 16 or 32 bit depth colour will only matter to multimedia development projects using JPEG files and a helper application for viewing.

The treatment was administered on two matched Power Macintosh 8100/80AV computers running under System 7.5, with 17" Apple MultiScan monitors. The computer desktops were matched for background (middle grey) and extraneous windows and desktop icons were removed.

Each subject completed the treatment individually and without consultation. Subjects were asked to compare pairs of images as they appeared on the screen, and judge which image had the higher quality. Selections were made by clicking on buttons beneath each image (see Figure 3).

Figure 3. Screen sample from the image quality experimental treatment.



Results:

The paired comparisons data were used to construct a Thurstone scale. Figure 4 is a graphic display of the Thurstone scale points. One of the advantages of Thurstone scaling is that it provides a method for representing distances meaningfully. Graphically, it is easy to describe the relative positions of the quality ratings. The rank order of Thurstone scale points is presented in Table 1 (1=highest quality rating, 6=lowest quality rating).

File sizes of the image files were obtained from the "Get Information" system function on Macintosh System 7.5.

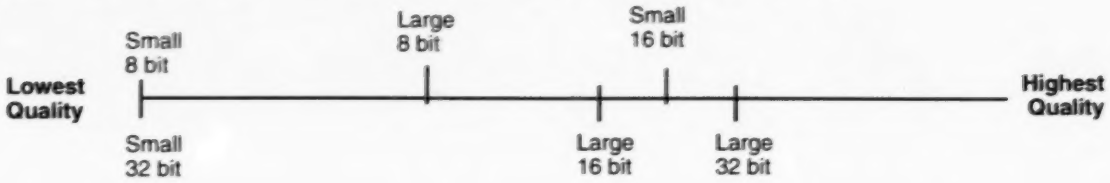
Loading times were obtained by creating separate HTML documents for each GIF image with no other information in the document. A home page was created with links to the picture documents, and all of the documents were housed in a single folder on the computer's hard drive. Loading times were measured with a stopwatch from the time the mouse was clicked on the link in the home page until the complete document appeared.

Table 1. File size and loading time and quality rating for different size images and different bit depths.

Image	File Size (Kb)	Loading Time (seconds)	Thurstone Scale Point	Thurstone Scale Ranking

648 x 463 (32 bit-JPEG)	442	9	4.24	1
320 x 229 (32 bit-JPEG)	215	4	0.00	5 (tie)
648 x 463 (16 bit-JPEG)	476	9	3.39	3
320 x 229 (16 bit-JPEG)	215	4	3.81	2
648 x 463 (8 bit-GIF)	553	4.5	2.43	4
320 x 229 (8 bit-GIF)	68	2	0.00	5 (tie)

Figure 4. Graphic representation of Thurstone scale points for images.



The loading times for pictures from the hard drive of the computer suggested that higher quality images (either 16 or 32 bit colour depth) can be achieved by approximately doubling the loading time needed for an 8 bit image. This may not appear to be a high cost to the developer until one remembers that these images and documents were loaded directly from the hard drive of the computer. No network or telephone lines were involved, thereby rendering a very optimistic data set. Slower transmission rates over various carriers would also double for higher quality images, and the slower the carrier, the more aggravating the result for the user.

Generally speaking the Thurstone scale suggests that for larger pictures, extra colour depth is desirable, but it is of little consequence with smaller pictures. On the whole, the group preferred large pictures, with the smaller 16 bit image providing an interesting anomaly. When larger versions were compared, the bit depth was picked out, and subjects rated the quality of the images in ascending order, from lowest to highest bit depth of colour.

Not so for smaller pictures. Bit depth of colour seemed to have little to do with the quality ratings given the pictures. The similar low ratings of smaller 8 and 32 bit pictures could indicate that the two images are inseparable visually. This is not likely, however, given that the smaller 16 bit picture had a higher quality rating than the other two smaller pictures. It may be that there is an optimal colour depth for different size images, one which takes maximum advantage of the colours available. It could also be that picture size is so influential that the companion variable (bit depth of colour) is virtually ignored. This deserves further study.

Movie Use and Display

Our best advice is to avoid using movies at almost any cost, unless of course the movie is an essential part of the instructional material, and the material can't be depicted any other way. At the present time and under almost every condition, digital movies are poor in quality. When downloaded from a web site, movies require companion programs to run (thus frustrating many users), and they are agonizingly slow to execute (further frustrating users). At the very least, whenever you must use movies, sound and larger image files, allow the user the option to link to the files rather than open them automatically on the page. As part of the link, warn the user of the size of the file. It is also courteous to use thumbnail sketches in the home documents and link them to larger versions if the smaller image can give the user an idea of the content of the larger file.

Also remember that helper applications (viewer applications) are required by most browsers to play sound files and movies. Notify users of file types to discourage time consuming and futile down-loads.

There are two ways to reduce the size of movie files:

1. reduce the size of the movie window; or

2. reduce the number of frames/second of the recording.

Movies can be recorded in various sizes, including quarter, half and full screens. They can also be recorded at any number of frames per second up to 30 frames per second, which is the standard rate for NTSC video playback. Each frame of video requires additional file space, so the greater the number of frames per second, the greater the resulting file size. But there is a further complication. Unless fairly sophisticated, high-end production software and hardware is used, computers cannot record 30 frames per second. Indeed, even if recorded, few computers are capable of playing back larger video windows at 30 frames per second.

Adjustments to either of these variables (window size, frames per second) may also reduce the perceived quality of the image when it is displayed on screen. As with the question of image quality we were unable to find any research which addressed these questions, so we designed an experiment to determine the actual costs and perceived quality differences when the window size and frames per second of a digital movie are manipulated.

Research Questions:

How will larger and smaller movie windows compare in file size, loading time and perceived image quality?

How will recording digital movies at different frames per second influence their file size, loading time and perceived quality?

Subjects:

Fifteen graduate students and senior undergraduate students studying educational technology, and seventeen adult employees at the University of Saskatchewan volunteered to participate in the study.

Treatment:

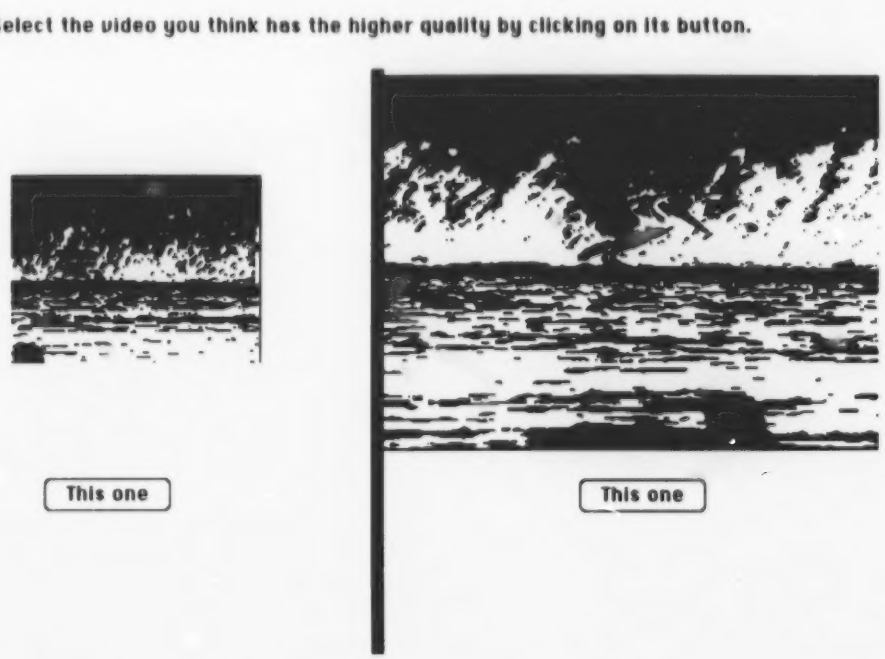
To measure perceived image quality, six versions of a 30 second clip of video were digitized as QuickTime movies. The original video was recorded on a Sony Betacam and transferred to videodisc. A segment was chosen which had few colours (to reduce possible contamination from this variable) but a great deal of detail and almost

continuous motion. The digital versions were recorded in two window sizes (quarter and half) and three settings of frames per second (30, 15 and 10) without key frames or audio using Apple's FusionRecorder 1.0.2 with a Power Macintosh 6100 with 16 Mb of RAM and 2 Mb of VRAM. Each movie file was imported into a program created with Authorware Professional v. 2.2, and a series of "pages" were created to provide a paired comparison of every possible combination of movie variables under study. The order of comparison was constructed according to recommendations by Ross (1934) for conducting paired comparisons to eliminate effects of picture location and presentation order. A Thurstone Scale was constructed for comparing resultant data (Torgerson, 1958).

The treatment was administered on two matched Power Macintosh 8100/80AV computers running under System 7.5, with 17" Apple MultiScan monitors. The computer desktops were matched for background (middle grey) and extraneous windows and desktop icons were removed.

Each subject completed the treatment individually and without consultation. Subjects were asked to compare pairs of movies as they appeared on the screen, and judge which movies had the higher quality. The movies played continuously until a selection was made. Selections were made by clicking on buttons beneath each movie (see Figure 5).

Figure 5. Screen sample from the movie quality experimental treatment.



Results:

The paired comparisons data were used to construct a Thurstone scale. Figure 6 is a graphic display of the Thurstone scale points for the digital video. The rank order of Thurstone scale points is presented in Table 2 (1=highest quality rating, 6=lowest quality rating).

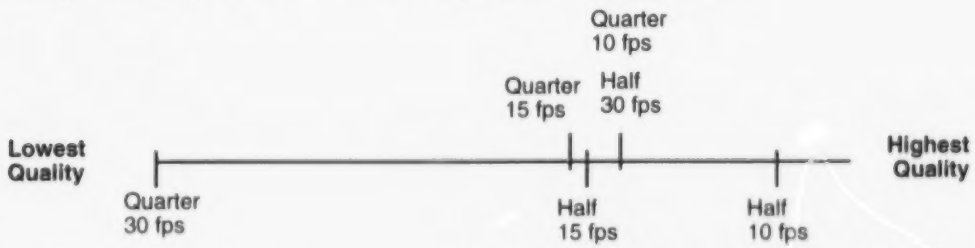
File sizes of the image files were obtained from the "Get Information" system function on Macintosh System 7.5. To load movies in HTML documents, they must first be "flattened." Adobe Premier, a video editing program for the Macintosh, was used to flatten the QuickTime movies.

Loading times were obtained by creating a home page with links to the movie documents, and all of the documents were housed in a single folder on the computer's hard drive. Loading times were measured with a stopwatch from the time the mouse was clicked on the link in the home page until the movie appeared.

Table 2. File size, loading time, playback rate and quality rating for QuickTime movies.

Window Size and FPS	Original Movie Size (Mb)	Average Loading Rate (seconds/ Mb)	Total Loading Time (min:sec)	Thurstone Scale Point	Image Quality Ranking
Quarter (30fps)	9.3	43.3	6:40	0.00	6
Half (30fps)	32.8	42.2	23.10	0.27	2 (tie)
Quarter (15fps)	4.5	45.7	3.26	0.24	5
Half (15fps)	16.9	42.3	11:54	0.25	4
Quarter (10fps)	3.2	46.2	2:28	0.27	2 (tie)
Half (10fps)	11.9	44.5	8:50	0.36	1

Figure 6. Graphic display of Thurstone scale points for digital video.



The most dramatic data are the loading times for video. Loading times ranged from 2.5 minutes to more than 23 minutes, depending on file size. Few users will wait 23 seconds for a movie, much less 23 minutes. For video to be a viable instructional option with HTML, loading times must improve exponentially.

It appears that the size of the video window is more important than frame speed (Figure 6). Subjects, on the whole, preferred the larger images, and an interesting correlation with frames per second may be indicated by the data. For smaller video segments, there was an inverse relationship between frames per second and the quality rating. A similar, but less perfect relationship was found with larger video

images. The computers used in this instance were not able to process 30 frames per second—something less than that was actually displayed. They were, however able to process 10 frames per second. We speculate that the resultant similarity between the recording rate and playback rate may result in a smoother appearance to the displayed video. This is worthy of additional research.

Summary

HTML was specifically designed to distribute hypermedia on the World Wide Web, and it does so--within limits. We urge would-be developers of multimedia who are contemplating using the WWW to keep in mind some of the factors discussed in this paper, and to proceed with only those projects that are viable despite current limitations of hardware (both in the distribution technology and on the desktops of learners). While richly-colored graphics and video emit a siren call to developers, developers must keep in mind the potential "wait times" they may inadvertently inflict upon learners, most of whose equipment will not likely have the computational horsepower of the machines on which development took place. The limited bandwidth of most carriers and the slower speed of many computers makes the use of multimedia on the WWW awkward and of questionable worth. Still, technology will continue to improve, and given the enormous popularity of the internet for sharing information, it is likely that its capacity for dealing with multimedia will improve dramatically.

Even when contemplating using HTML as the basic tool for CD-ROM development (e.g., see Misanchuk and Schwier, 1996), developers should be circumspect in their use of graphics and, especially, video. The pilot studies reported here lead one to believe that quality (in the eyes of the learner) may not always be reflective of technical superiority. Despite the fact that small 32 bit still pictures were ranked lowest in quality, right along with small 8 bit pictures, and that 30 fps quarter-size video ranked lowest in quality while 10 fps half-size ranked highest, size alone is probably not the answer (since small 16 bit pictures ranked between large 16 bit and large 32 bit ones). Clearly more investigation is needed before robust guidelines can be formulated to help designers choose optimal (as opposed to maximal) size, colour depth, and frame rates. For the moment, file size and the initial findings reported here can be used as guides, but we caution that the studies need to be replicated with multiple stimuli of a demonstrably more instructional nature.

At present, we suggest that the limitations of HTML on the WWW as a multimedia architecture largely argue against its use for interactive multimedia projects. However, along with most developers on the World Wide Web, we eagerly anticipate improvements which will make the internet viable for delivering interactive multimedia.

References

Frost, M. (1996). Creating an image map. *The Net, 1*(8), 74-77.

Graham, I. S. (1995). *HTML sourcebook: A complete guide to HTML.* Toronto: John Wiley & Sons.

Misanchuk, E. R. , & Schwier, R. A. (1996). *Benefits and pitfalls of using HTML as a CD-ROM development tool.* Paper presented at the Annual

Convention of the Association for Educational Communications and Technology, Indianapolis, IN, February 12-16, 1996. Available in electronic form from http://www.extension.usask.ca/Papers/Misanchuk/AECT96/Benefits&Pitfalls.html.

Ross, R. T. (1934). Optimum orders for the presentation of pairs in the method of paired comparisons. *The Journal of Educational Psychology, 25*, 375-382.

Torgerson, W. S. (1958). *Theory and methods of scaling.* New York: John Wiley & Sons.

Appendix 1
Addresses to clip art and icon collections on the World Wide Web

-- http://www.dorsai.org/~ackerman/clip.html
-- http://www.wellesley.edu/Gifs/
-- http://pauillac.inria.fr/~lang/hotlist/clipart/
-- http://thorplus.lib.purdue.edu/~carl/IconBib.html
-- http://barrow.uwaterloo.ca/~ghballin/wedpage.html
-- http://www-c8.lanl.gov/icons/main.html
-- http://www.cs.yale.edu/homes/sjl/clipart.html
-- http://www.itec.sfsu.edu/multimedia/Clip-art.html
-- http://www-c8.lanl.gov/icons/man.html
-- http://pasture.ecn.purdue.edu/~staleyr/www.html
-- http://pasture.ecn.purdue.edu/~staleyr/www.html
-- http://www.emf.net/~troop24/icons/clipart.html
-- http://miso.wwa.com/~boba/images.html
-- http://www.monash.edu.au/alst6/com/nate/WWW/corelclipart.html
-- http://web66.coled.umn.edu/Share/Share.html
-- http://www.ocf.org/OrthodoxPag/icons/icons.html
-- http://users.aol.com/newblossom/SC.Catalog.html
-- http://www.mordor.com/ellison/desktop.html
-- http://baste.magibox.net/~jhaley/
-- http://www.adobe.com/imageclub/html/info/info-index.html
-- http://dutera.et.tudelft.nl/people/vdham/info-mac/IM146-13.html
-- http://www.mindspring.com/~guild/graphics/graphics.html
-- http://www.iohk.com/sensa.html
-- http://quasar.fastlane.net/homepages/britton/
-- http://www.zia.com/educate.htm
-- http://www.adobe.com/imageclub/html/new/new-index.html
-- http://www2.ncsu.edu/bae/people/faculty/walker/hotlist/icons.html
-- http://www.mordor.com/ellison/business.html
-- http://www.interlog.com/~rdg/
-- http://www.cdarchive.com/big_group_of_files_number_1/09A.htm
-- http://osiris.colorado.edu/~brumbaug/graphics.html
-- http://asrt.cad.gatech.edu/home/develop.html
-- http://www.mcli.dist.maricopa.edu/info.html
-- http://mtmis1.mis.semi.harris.com/new_mtop.html
-- http://galen.med.virginia.edu/~baj7d/BaDge77.html
-- http://www.primenet.com/~accord/computng.html
-- http://www.ies.luth.se/~tim/
-- http://www.tezcat.com/~sstrong/
-- http://esu3.esu3.k12.ne.us/curriculum/resourcepage.html
-- http://www.xmission.com/~pengar/homeboys/links.html
-- http://rintintin.colorado.edu/~chrisw/wwwftp.htm
-- http://www.iquest.net/dewpoint/pricing.html
-- http://www.zdnet.com/~macuser/mu_1195/reviews/authorware.html
-- http://www.northcoast.com/savetz/pd/pd.html
-- http://www-genome.wi.mit.edu/WWW/resource_guide.html
-- http://dutera.et.tudelft.nl/people/vdham/info-mac/IMt146-13.html